噴石衝突に対する木造建築物屋根の衝撃吸収特性
Impact absorption properties of wooden buildings roof subjected to ballistic block collision

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Volcanic disasters include various factors such as eruption, lava flow, pyroclastic flow, debris avalanche, debris flow and so on. Especially, at the phreatic eruption of Mt. Ontake in September 27, 2014, most of the damages were caused by clashes of ballistic block. In order to prevent these damages, it is suggested that evacuation to a mountain hut is effective. Thus, evaluation of impact absorption properties for wooden buildings (e.g. mountain hut) against ballistic block collision is necessary. Previously, we reported the protective abilities of as-built wooden buildings, which were reinforced with high performance fabric using aramid fiber. In addition, the penetration boundary energy for a 15 mm thick wooden building roof was reported. However, the impact absorption properties of various type wooden buildings has not been clarified enough. Therefore, in this study, impact absorption properties of wooden buildings roof subjected to ballistic block collision was experimentally investigated.

A collision test was carried out at the velocity of 10 to 90 m/s using a large scale launching system. In this system, a projectile was accelerated by compressed air and then collided with the target. The projectile velocity was measured using two lasers and light receiving parts. In many cases, size of the ballistic block is almost the fist size (φ100 mm) under phreatic eruption. Therefore, Vitrified whetstone similar to the common ballistic block (density: 2400 kg/m^3) was used as the projectile, and the diameter was determined φ90 mm (mass: 2.66 kg). For the target, typical wooden roof structure (e.g. cedar boards, waterproof sheet, galvalume steel plate and cedar rafter) was used. Two types of thickness of cedar board (15 mm and 18 mm) were prepared. The thickness of the waterproof sheet and galvalume steel plate were 1.0 mm and 0.4 mm, respectively. The dimensions of the specimen were 600 mm ×600 mm. The components were fixed with nails and its spacing was approximately 150 mm. In addition, specimens in which two cedar plates were superimposed was also prepared. There are two kinds of superimposing methods: a ”staggered structure“ that is alternately superimposed on one another, and a "cross structure" in which plates are orthogonalized.

Collision test results revealed penetration boundary energies of 15 mm and 18 mm specimens, respectively. In previous study, it was shown the maximum collision energy of volcanic ballistic block (φ2-64 mm) was 1700 J (in the case of φ64mm, 100 m/s), and average collision energy was less than approximately 1200J in many cases. From the result, it was revealed that the roof of cedar board having a thickness of 15 mm and 18 mm could prevent penetration of volcanic ballistic block. In addition, it was found that by superimposing the cedar boards, impact absorption properties can be improved simply. At the time of superimposition, the impact absorption properties was hardly improved in the ”staggered structure”. However, in the "cross structure", it was confirmed that the impact absorption properties were greatly improved. From this it was found that the "cross structure" is better when reinforcing by simple superimposition.

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